

Space Weather Technical Forecast

Issued on Wednesday, 15 November 2023 at 12:44 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales <https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales>

Space Weather Forecast Headline: Slight chance of G1/Minor Geomagnetic storm day 1 (15 Nov). Decreasing chance of further M-flares.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Moderate, with one M-flare observed, peaking M1.0 at 14/2305 UTC from AR3485. There are four sunspot regions on the disc. AR3485 is close to the southwest limb, and is now difficult to observe. AR3486 also in the southwest, is the largest region on the disc, with some ongoing flux emergence. AR3487 is another southwest disc spot, however this is a small and simple bipolar region. AR3488 is amongst the plage in the northeast, but is a very small and simple unipolar spot. No Earth-directed CMEs have been observed.

Solar Wind / Geomagnetic Activity: Solar winds, as observed at L1 by ACE and DSCOVR likely showed the passage of a very weak CME from an uncertain source yesterday (14 Nov). Wind speeds were background to slightly elevated at 360-410 km/s. Density was largely at or just below average. Total magnetic field strength (Bt) was Moderate, 10-13nT at first, but eased to be predominantly Weak after 14/2330 UTC. The north-south component (Bz) was generally weakly negative (southward) from 14/1220 UTC, with minimum -8nT, but did change to be weakly positive at times. Phi angle was mainly positive (away from the Sun). Geomagnetic activity has been Quiet to Unsettled (Kp 1-3).

Energetic Particles / Solar Radiation: GOES16 high energy (greater than 10MeV) proton flux remained at background. GOES16 high energy (greater than 2MeV) electron flux was at background. The associated 24-hour fluence was below the Active (1e8 integrated pfu) threshold. The fluence observation at 15/0000UTC was 2.33e6 integrated pfu.

Four-Day Space Weather Forecast Summary

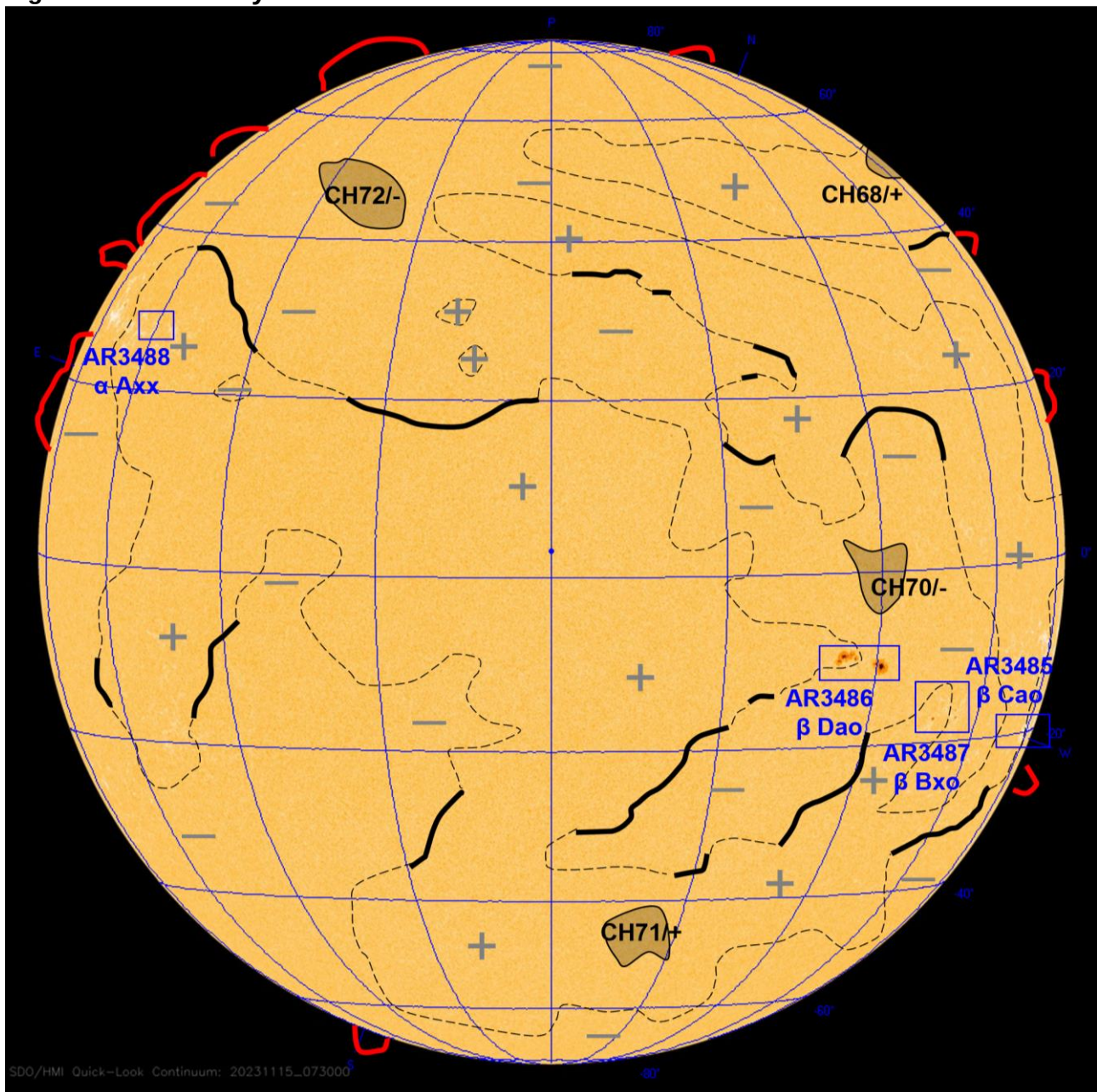
Solar Activity: Generally Low, but with a decreasing chance of rising to Moderate with any isolated M-flares.

Solar Wind / Geomagnetic Activity: A slow CME from the eruption and dimming event on 10 Nov has the potential to give a glancing interaction later on day 1 (15 Nov), however this is low confidence and any enhancement is currently expected to be limited. A further slight enhancement is likely days 1-2 (15-16 Nov) from a connection to the fast wind of small CH70/-, with speeds potentially reaching 450 km/s, easing day 3 (17 Nov) onward. Mainly Quiet geomagnetic activity at first, rising to Unsettled to Active later day 1 and into day 2 (15-16 Nov). Any combined effect of the CME and coronal hole HSS will bring a slight chance of an isolated G1/Minor geomagnetic storm. Activity easing to be Quiet with isolated Unsettled intervals day 3 onward (17 Nov).

Energetic Particles / Solar Radiation: GOES16 High energy proton flux is expected to remain at background. GOES16 High energy electron flux is likely to rise through the period as any elevated electron populations at lower orbits relax back towards GEO. This is low confidence however, especially with the potential for further weak enhancements to the solar wind on day 1 (15 Nov). The associated electron fluence is likely to remain below the Active threshold (1e8 integrated pfu) but with an increasing slight chance of rising above.

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

Figure 1. Solar Analysis Valid 15/0730 UTC.



Key: Filament —, Prominence —, Magnetic Field Line - - -, Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-γ-δ and Zurich-McIntosh Axx etc.

Geomagnetic Storms:

A slow CME was observed on 10 Nov resulting from a weak eruption between AR3484 and AR3485 in the southwest quadrant, along with associated coronal dimming. This has been modelled as just ahead (west) and south of Earth, but with a glancing impact possible later on day 1 (15 Nov). Any impact is likely to be minimal however, with the CME indistinct in imagery and travelling at a similar speed to the background slow wind, which is currently at around 350km/s.

A further potential enhancement is possible however, due to the small central disc coronal hole CH70/-. This is expected to give a period of slightly enhanced solar winds, to around 400-450km/s, with onset most likely later on day 1 or day 2 (15-16 Nov), before quickly easing to background day 3 onward (17 Nov). This is slightly later than current MOSWOC Enlil expectations, which is considered too early with the onset of any CH70/- HSS.

Mainly Quiet geomagnetic activity at first, rising to Unsettled to Active later day 1 and into day 2 (15-16 Nov) from either the fast wind enhancement, or any glancing interaction from the CME. Any combined effect will bring a slight chance of an isolated G1 Minor Storm. Activity easing to mainly Quiet day 3 onward (17 Nov).

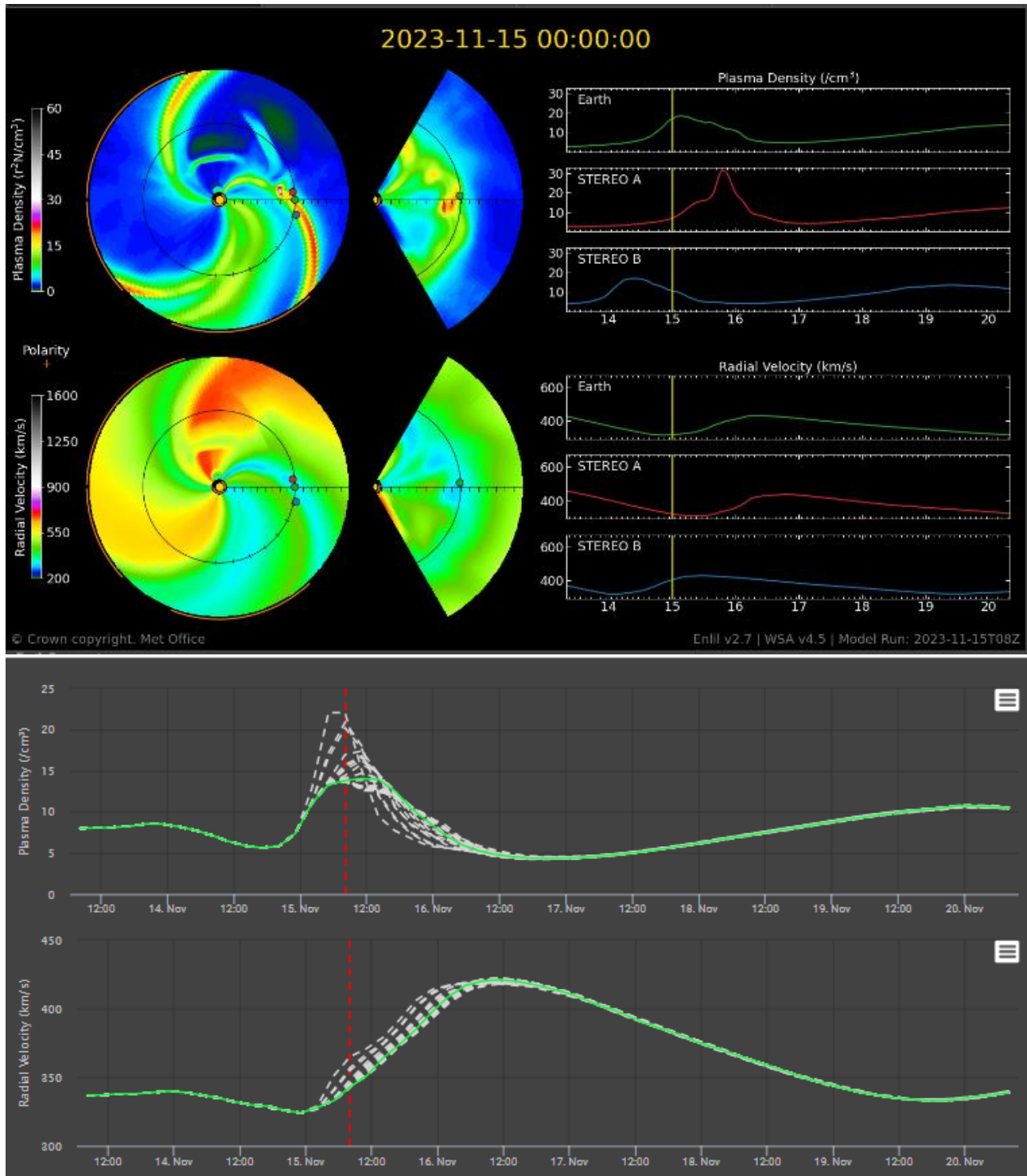
Geo-Magnetic Storm	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Minor or Moderate	G1 to G2	No	15	5	1	1
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
11/0633	NIL	Filament	SW	378	15/1200 +/- 12 hrs	Low confidence Glancing impact.



Figure 2: Enlil and ensemble showing weak CH and CME arrival





Radio Blackouts - X-Ray Flares:

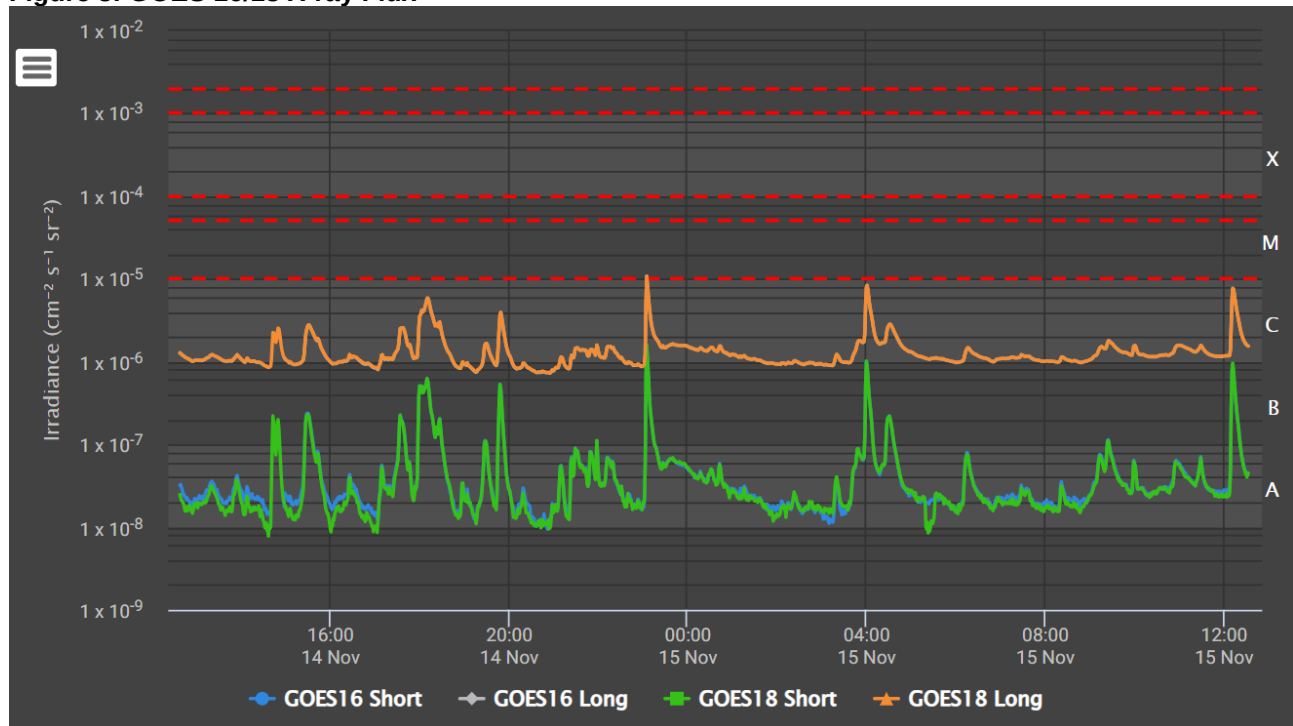
Solar Activity is expected to be Low-Moderate, with a slight chance of isolated M-flares.

There are four small sunspot regions on the disc. AR3485 was the source of the M1 flare on 14 Nov, however this is increasingly hard to see and will soon move over the southwest horizon day 2 (16 Nov). AR3486 and AR3487 are also in the southwest quadrant. Of these AR3486 is the most notable as the largest region on the disc with ongoing slow flux emergence, previous intermediate spots have now combined into the main leader and trailer spot. AR3487 is a smaller and simpler region. Both of these will move off the disc by the end of the period.

The only other region on the disc is small AR3488 near the northeast limb. This is a very small region set amongst plage, but there is the potential for more details to become apparent or develop as it moves to a less oblique viewing angle.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	Yes	20	20	15	10
Very Active	R3 to R5 X Class	No	1	1	1	1

Figure 3: GOES 16/18 X-ray Flux



Solar Radiation Storms - (High Energy Protons):

The high energy (greater than 10MeV) proton flux observed by GOES16 is currently at background levels and expected to persist at this level. There is a very slight chance of flux rising from any significant flares or filament eruptions off the western disc, or just over the western limb, however this unlikely to reach the S1 Minor Radiation Storm level.

Radiation Storms	Level (cm ⁻² sr ⁻¹ s ⁻¹)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ S1	No	2	2	1	1
Very Active	≥ S3 *	No	1	1	1	1

* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = cm⁻²sr⁻¹s⁻¹)

High Energy Electrons Event (≥ 2MeV):

High energy electron flux (greater than 2MeV) at GOES-16 has persisted at background. This is despite recent enhancements which likely increased electron populations at lower orbits (LEO/MEO). These electron populations have the potential to relax back to GEO, with periods of Moderate becoming increasingly likely, perhaps reaching High flux (1000 pfu) at diurnal peak. However there is also the potential for any enhancement from the glancing CME and CH70 on days 1-2 (15-16 Nov) to limit the extent that this occurs. Coupled with a natural decline, the extent of any increase in the observed flux remains low confidence.

The associated 24 hours fluence is expected to persist below the Active level, but with an increasing chance of rising above due to the low confidence with how flux levels will respond to any solar wind enhancements, and also the potential higher flux at LEO AND MEO. This appears to be supported by REFM, which keeps flux at low levels, however this model doesn't take account of any electron flux increase due to the recent solar wind enhancements

GEO Electron Environment	Level (cm ⁻² sr ⁻¹ day ⁻¹)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ 2 MeV ≥ 1x10 ⁸	No	5	10	20	25
Very Active	≥ 2 MeV ≥ 1x10 ⁹	No	1	1	1	1

Figure 4: GOES 16 >2MeV electron flux (top) and MOSWOC REFM fluence model forecast and recurrence (bottom)

